temperature increases within limits, the moisture content of the air should increase to maintain the condition of growth constant, and we know that a high temperature and a high wind velocity work together in taxing the powers of a plant. Now, for an increase of 10° in temperature, how much does the relative humidity need to be increased? Or what relation has the wind velocity per hour-mile to a degree in temperature in relation to the development of plants? If we have the same temperature and the same wind velocity over two successive periods, and the normal wind velocity over one, and twice the normal wind velocity over the other of the two periods, the effect upon a growing plant would unquestionably be great. With this increased movement, how much would the temperature need to be lowered in order that the conditions would be the same over each period and the wind not retard the development of the plant?

It seems as though numerical relations of this kind can be established between the principal meteorological elements. These numerical relations of the meteorological elements will unquestionably differ, as stated in my paper, not only for different plants, but for the same plant in different periods of its growth. The equation was intended really to show the variation in the climatic conditions from the normal. In order to use this intelligently of course the normal conditions must be worked out so that departures from the normal can be appreciated. As you say, the nature of the soil and the character of the plant has much to do with the development of the plant. That was taken for granted in giving to soil moisture a place in the equation, and in taking it for granted that the previous breeding of the plant used for establishing the relations in the equation had been known.

This equation is simply constructed to show the relation of meteorological data, and can be used, of course, with all life. I had originally intended to use the word "life" instead of the mere specific term "plant," but I decided upon the use of a plant as giving a more concrete form to the expression.

I hope you will see from this that these ideas of climatology are broad enough to include all life and human industries. The one formula, of course, will not stand, but the principal of equating the meteorological data should be applicable to the widest possible sphere. It is alike applicable to animal life and human industries as it is to plant life.

It seems to me that as yet we have very little "general climatology," and until the principles of this are well established and we know something of the relations of meteorological phenomena to life and industries, that it is hardly time to specialize, as Mr. Ward suggests, and have "agricultural climatology" and "anthropo-climatology," and what may come to be known as "industrial climatology." I think when Mr. Ward works out any units or relations between meteorological phenomena and man, that it can be connected with but little trouble with other forms of life and with human industries from what we already know of the relations between plant and animal life and human industries.

ERRONEOUS CONVERSION OF METRIC AND ENGLISH BAROMETER READINGS.

By Prof. C. F. MARVIN, Chief of Instrument Division.

The growing interchange of meteorological observations between the Weather Bureau and observers throughout the West Indies, Mexico, Central America, and elsewhere gives rise to many occasions in which readings of atmospheric pressure must be converted from French to English measures, or vice versa. We desire to caution observers and others against an errer which is liable to be committed in this connection when dealing with uncorrected readings of mercurial barometers with brass or similar scales affected by temperature. For example, suppose the readings of the attached thermometer and scale of a mercurial barometer graduated in metric units are:

Attached thermometer	25.4° C.
Barometer reading	762.15 mm.

As it is desired to ascertain the corresponding air pressure in English units when the observer does not happen to have at hand a table giving corrections for temperature in metric units, he may now endeavor to use his table of corrections in English units instead, and will sometimes be inadvertently led into an error in making the conversion. That is to say, he will convert the temperature from Centigrade to Fahrenheit and the scale reading from millimeters to inches. In the present case this gives attached thermometer 77.7° and barometer reading 30.006. The temperature correction corresponding to 77.7° and 30 inches, as given by his table for English barometers, is —0.133, and he therefore concludes that the observed barometer reading in English units and corrected for temperature is 29.873. This process, however, leads to an erroneous result.

The correct conversion is found by taking the correction for temperature corresponding to 25.4° C. and 762 mm. from a table of corrections for temperature *in metric units*. In the present case the correction is —3.15 mm.; therefore, the corrected barometric reading is 759 mm., which converted into inches gives the true result, namely, 29.882 inches. The error thus pointed out results from two circumstances: First, that the metric and English scales of length are not standard at the same temperature; second, that all ordinary tables of barometric corrections for temperature include the effects of temperature on both the mercurial column and the brass scale. Scale readings of metric measures of length are standard at 0° C., that is, the freezing point, or 32° F.; whereas an English scale of inches is regarded as standard at 62° F. In both cases the height of the mercurial column is standard when the temperature is at the freezing point.

When, therefore, comparisons are being made between French and English barometers and all the readings are to be reduced to the same system of units, the observed readings must be separately corrected for temperature. This will require a table of corrections in metric measures for the French barometer and a separate table of corrections in English measures for the English barometer. The readings, after being thus corrected for temperature, are expressed in standard inches and millimeters, respectively, and may then be converted directly from one system to the other with correct results.

Generally the corrections for instrumental error and capillarity are so small that these may be applied either before or after correcting for temperature and the conversion of scale without appreciable affect on the result. If the corrections for instrumental error and capillarity are large, however, they should, to be strictly correct, be applied, after correcting for temperature, but before conversion to another system of units. Notwithstanding this rule, the graduated scale of barometers with relatively small tubes is often "set down," in order to compensate for the capillary depression of the mercurial column and to eliminate other instrumental imperfections which reduce the height of the column, such as an imperfect vacuum, for example. This setting of the graduated scale is an instrumental method of applying the correction for capillarity, etc.; but by applying it before and not after the correction for temperature it complicates the problem of attaining accuracy. However, any error thus introduced will ordinarily not exceed 0.001 of an inch, unless the depression of the scale is greater than about 0.2 of an inch.

We may remark, in this connection, that circumstances sometimes arise in which a Centigrade thermometer may be used to determine the temperature of an English barometer,

or a Fahrenheit attached thermometer may be used with a metric scale. In all such cases the temperature must be brought into the same system of units as the observed scale reading before corrections can be applied, and the observed reading must then be corrected for temperature before any conversion of the scale units can be made.

It need hardly be said that the foregoing remarks do not apply to readings of aneroid barometers whose corrections for temperature and instrumental error can not be definitely tabulated, each instrument requiring a specific table peculiar to that one instrument. These corrections are too generally quite ignored and not applied.

The proper course, in case barometric readings must be converted from one system of units to another, is to apply all known corrections expressed in the same system of units as that in which the observed scale reading is taken and then convert the corrected reading.

WEST INDIAN SERVICE.

By Prof. E. B. GARRIOTT, in Charge (dated August 3, 1898).

By virtue of an Act of Congress, approved July 7, 1898, the Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, was authorized, through proper diplomatic channels—

To establish and equip meteorological observation stations of the same general character as the stations of the Weather Bureau now maintained in the United States, at such points in the West Indies and on the coast of the mainland, bordering the Caribbean Sea, and on the islands adjacent thereto, as might be needed.

The purpose of the establishment and equipment of observation stations in the regions named was—

To have daily observations on meteorological phenomena taken at the several stations, to collect reports thereof, by cable and otherwise, and to disseminate information based thereon of the approach of tropical hurricanes or other storms to the West Indies, and to the coasts of the United States, and to collect and publish such further climatological data as might be of public benefit.

With the approval of this Act operations were actively begun to establish stations of observation and report. Communications requesting permission to do this were addressed through the proper official channels to the several European governments having jurisdiction in the West Indies, observers, skilled and trained in the work of the Bureau were selected, and the necessary instrumental equipment for stations was prepared for transportation to selected points. Observers reported their arrival at Willemstad, Curaçoa, July 21; at Santiago, Cuba, Kingston, Jamaica, Port of Spain, Trinidad, July 29; at Santo Domingo, Santo Domingo, and St. Thomas, August 5; at Barranquilla, Colombia, South America, August 11; at Bridgetown, Barbados, August 12; at St. Christopher (St. Kitts), August 18, and at Colon, Colombia, South America, August 29.

Observations were regularly begun at five of these, i. e., Kingston, Santo Domingo, St. Thomas, Port of Spain, and Willemstad, August 9, at Santiago, August 11, and at Bridgetown, Barbados, August 31. Similar reports have been received daily for a long time from Habana, Cuba; Nassau, Bahamas; and Hamilton, Bermuda.

The central station is located at Kingston, Jamaica, and all other stations of the system cable daily, to Washington and Kingston, reports of observations taken at 6 a. m. and 6 p. m., seventy-fifth meridian time. In the presenceof unusual weather conditions, or in the event of observed premonitions of approaching hurricanes, special observations are telegraphed. In addition, and supplementary to the above-named West Indian stations, daily morning and evening reports are telegraphed (beginning August 9) to Washington via Galveston, Tex., from Tampico, Vera Cruz, and Coatzacoalcos; these stations on the Gulf of Mexico are manned and observations contributed by the officials of the Mexican Telegraph Company. Daily reports are also received (beginning August 17) by telegraph from a local observer at Merida, Yucatan.

The present plan of hurricane warnings provides that upon the receipt by the Weather Bureau at Washington of telegraphic information of the development of a hurricane in the West Indian regions, warning of the location, character, and probable movement and strength of the storm be furnished at any hour of the day or night to the Chief of Bureau of Navigation, Navy Department, who has provided for a prompt transmittal of the information to our fleets in West Indian and southern waters. Similar advices will be cabled directly to West Indian and southern coast ports in the threatened district and every available means will be employed in the interest of the naval and merchant marine to give the most effective distribution to the warnings.

The service above outlined is at present an emergency service, which has been hastily organized to meet a demand on the part of naval and commercial interests for warnings of destructive storms in the Gulf, Caribbean Sea, and the West Indian Islands. It is not organized for local climatic studies, but it is confidently expected that through the cooperation of representatives of European governments having possessions in the West Indies, and of the countries bordering on the Caribbean Sea and the Gulf of Mexico on the south and west, a system of weather reporting stations can be permanently established, which will not only permit the forecasting of hurricanes and northers but allow of such a determination of the climatic conditions as will be a most important factor in developing the wonderfully rich agricultural resources of the West Indian Islands.

THE JAMAICA WEATHER SERVICE.[1]

By Mr. MAXWELL HALL, Government Meteorologist (dated August 15, 1898).

This Service was established in 1880 in order to have the usual instruments read and recorded at Kingston, the chief town in Jamaica, to encourage the registration of the rainfall throughout the Island, and to give warning of approaching hurricanes.

Mr. Robert Johnstone, F. R. Met. S., has assisted me from the first; he undertook the registration of the instruments in Kingston, and thereby allowed me to return to my private residence, the Kempshot Observatory, near Montego Bay. These places are 78 miles apart on the line of usual approach of cyclones along the Caribbean Sea. Consequently, by an exchange of telegrams Mr. Johnstone and I have been able to make out fairly well what any cyclone was doing, and to issue the proper telegraphic notice or warning.

At times, during the absence of Mr. Johnstone, I have been assisted by Mr. J. F. Brennan, who has shown unusual skill in improving self-registering instruments.

The registration of the rainfall has been encouraged by issuing a monthly weather report to all the contributors, of whom there are about 200; among these weather reports there are published any special reports or investigations.

With regard to storm warnings, according to a revised list, 38 depressions have passed within barometric range of Jamaica since the service was established, but many were so clearly

[1] The article here communicated in response to a request by the Editor was originally prepared by Mr. Maxwell Hall as a response to a request from the Royal Meteorological Society, and may possibly be published in abstract in connection with the annual address of its President, Hon. F. C. Bayard. With regard to the General West Indian Service, partially organized at one time by Mr. Hall, a full account will be found in his introduction to Volume I of the Jamaica Meteorological Observations. We are pleased to learn that the recent effort of the Weather Bureau to organize a West Indian system meets with Mr. Hall's heartiest approval. In fact there is every assurance of friendly cooperation on the part of all the meteorological organizations now existing in the West Indian region.—ED.